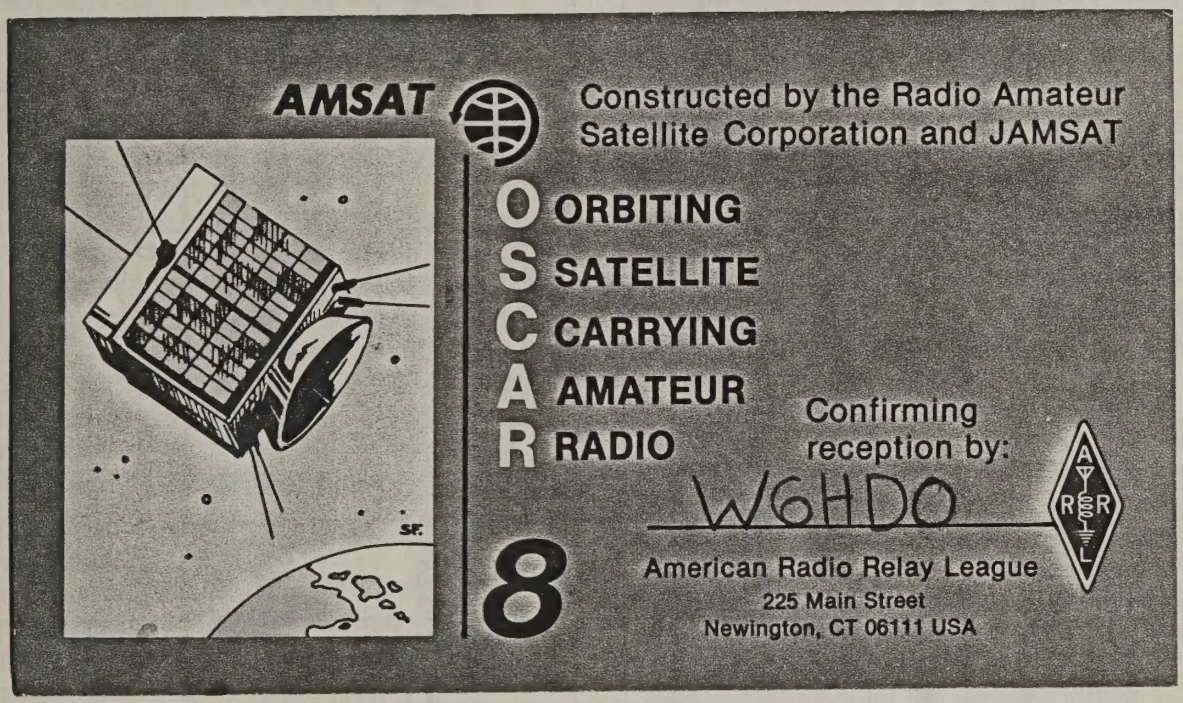
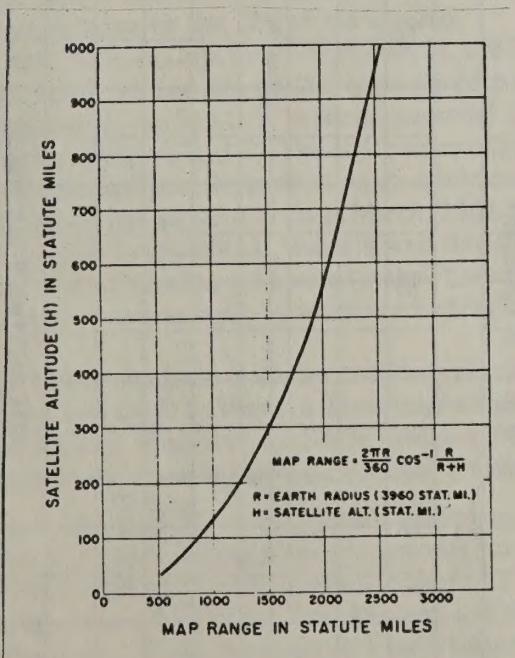
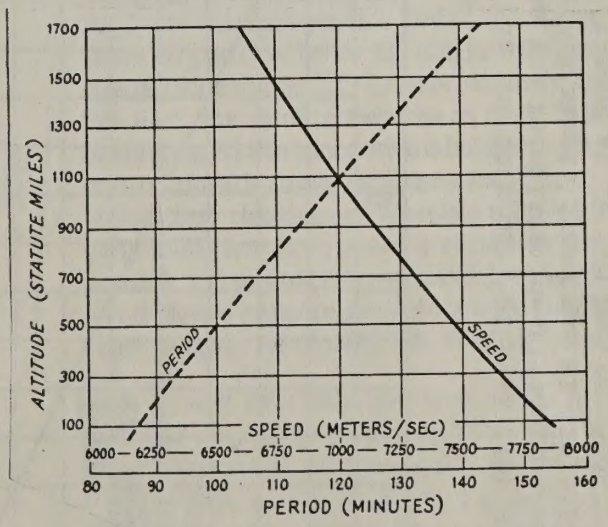
OSCAR/AMSAT
LECTURE NOTES:
Aug 27 1981
Cliff Buttschardt
W6HDO

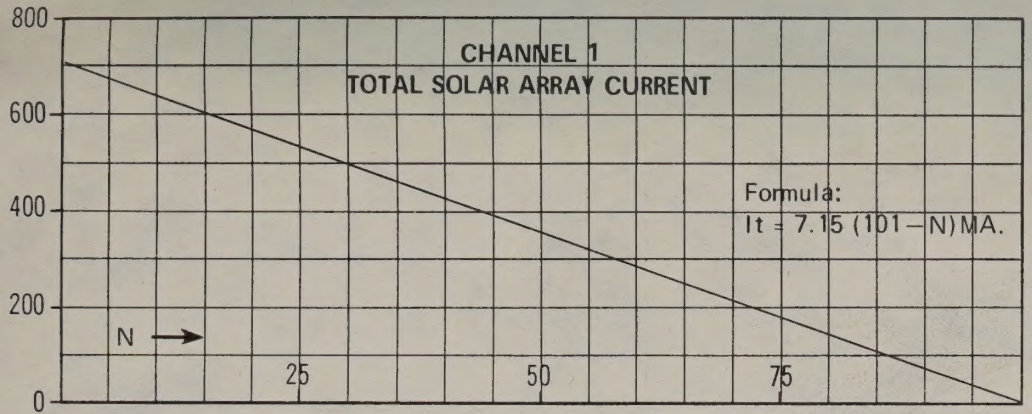
At the present time, only one amateur satellite is operational. OSCAR eight has two transponders and two beacons which transmit satellite telemetry. A QSL card is available from ARRL upon submission of a SASE with a frame of information included. How this is done is described on the reverse of this page.

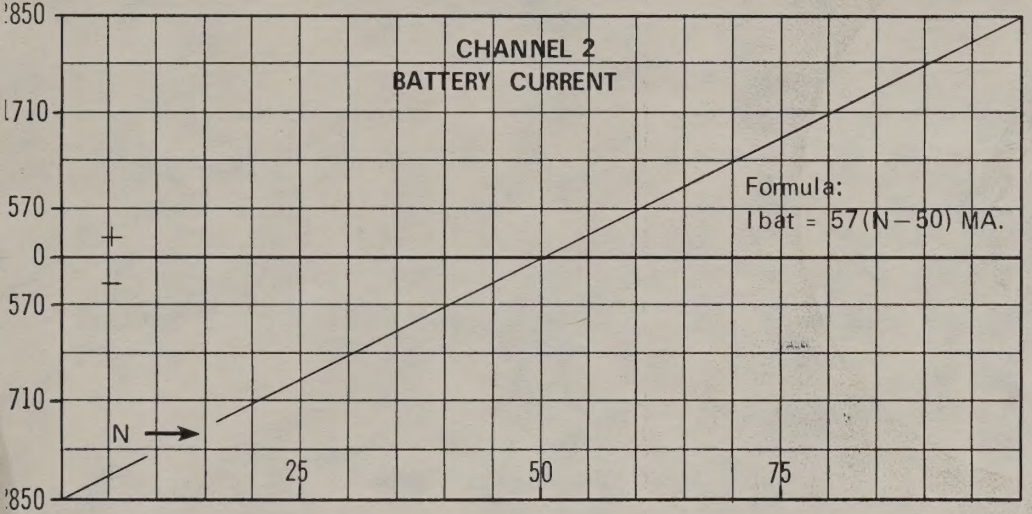


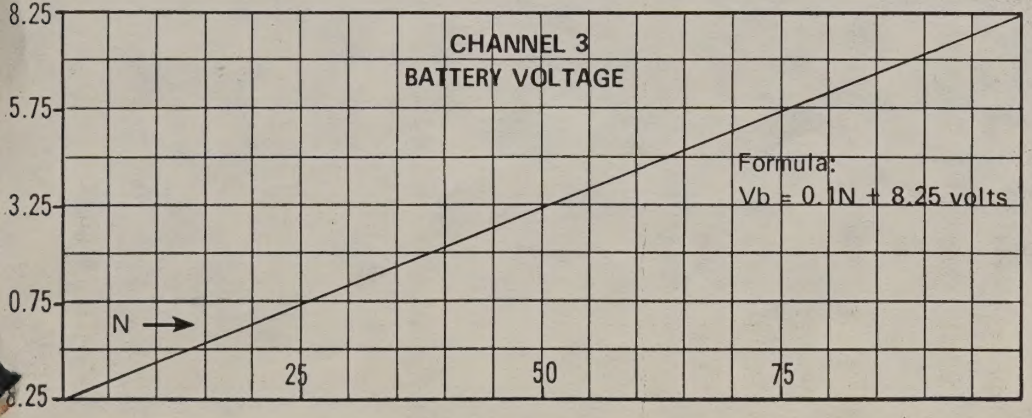

SATELLITE ALTITUDE (H) IN STATUTE MILES
MAP RANGE IN STATUTE MILES
MAP RANGE = $\frac{2\pi R}{360} \cos^{-1} \frac{R}{R+H}$
R = EARTH RADIUS (3960 STAT. MI.)
H = SATELLITE ALT. (STAT. MI.)

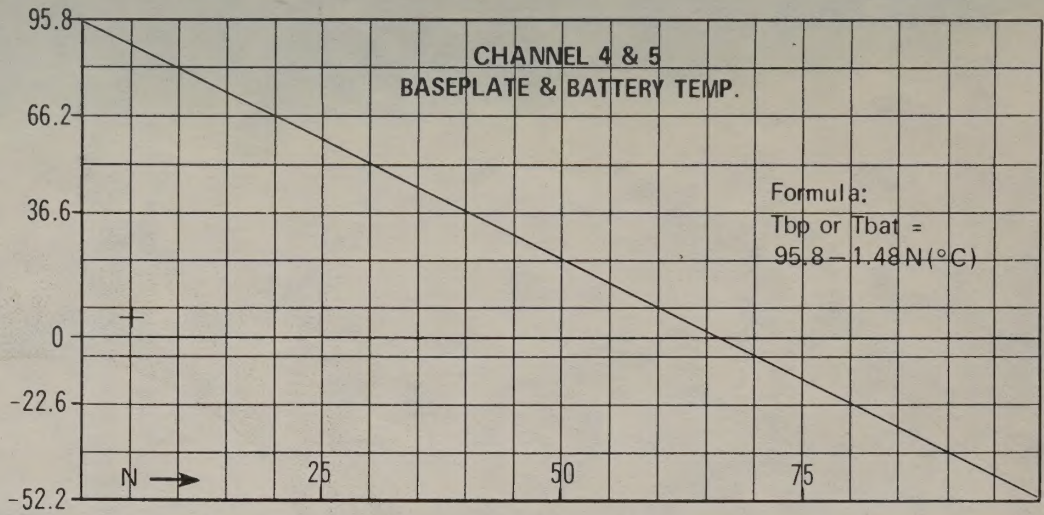


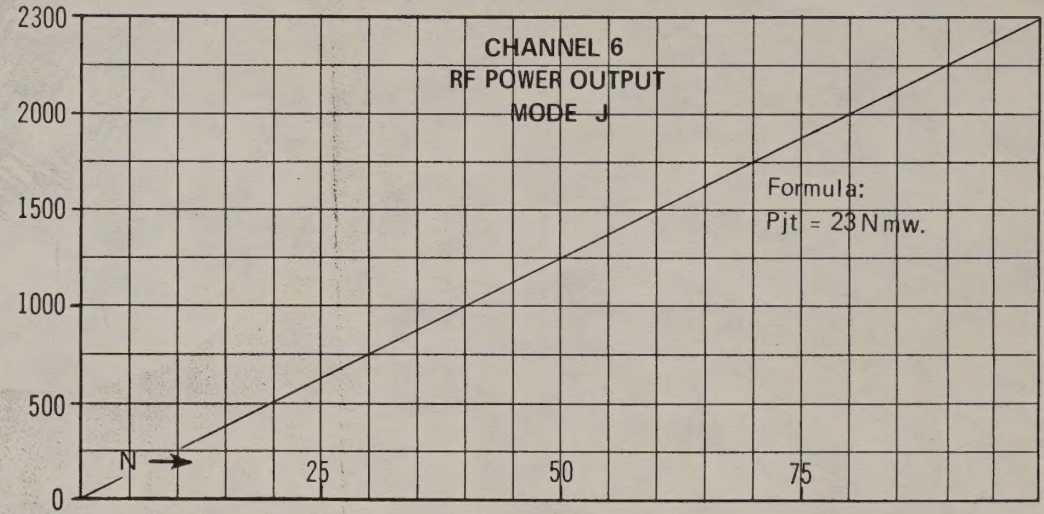
OSCAR EIGHT TELEMETRY NOMOGRAPHS











USER NOTES – COMMENTS

OSCAR 8 telemetry is in the form of : HI 1(N) 2(N) 3(N) 4(N) 5(N) 6(N). HI is the satellite identification and N is a two digit number. A sample frame is: HI 120,255,380,451, 551,620. Morse code is sent at 20 WPM and repeated every 20 seconds. Beacon frequencies are: 29.402 and 435.095 MHz.

W6HDO

HOW IT ALL BEGAN

Amateur radio officially began its sojourn into the satellite program on Dec. 12, 1961, when a simple 10 pound package of electronics was placed in orbit around our planet. The package, known as **OSCAR 1,** transmitted information concerning its internal temperature back to earth in the form of a timed CW "HI" on the 2 meter amateur band. The satellite was home constructed by a small group of amateurs in the California area (Fig. 1-4) and its free ride into space was accomplished by replacing a satellite launch rocket's dead weight ballast with the tiny package (Fig. 1-5). The 100 milliwatt transmitter aboard OSCAR 1 lasted approximately three weeks before its internal batteries discharged, and the satellite fell to earth soon thereafter. Consequent reports of OSCAR 1 reception from over 600 amateurs in 25 countries indicated solid interest in amateur satellites, thus plans for another "bird" were begun.

OSCAR 2 was launched from Vandenburg Air Force Base in California on June 2, 1962. This satellite was identical to OSCAR 1, except its transmitter ran slightly higher output power. A simple spring mechanism separated the satellite from the launch vehicle, and another spring swung its antenna into position. OSCAR 2 lasted approximately 2½ weeks befor its non-rechargeable batteries died. Over 700 reports of reception again proved support for amateur satellites, and additional plans were instigated.

OSCAR 3 was launched on March 9, 1965, and it made history as amateur radio's first full communications satellite (Fig. 1-6). The one watt, 2 meter linear transponder aboard this craft relayed CW, SSB and FM signals from amateurs around the world. Approximately two weeks after this satellite was placed in orbit, its internal batteries died, and the unit ceased to function. Although a bank of solar cells were incorporated in this satellite, they were strictly for battery back-up rather than for recharging. Over 100 amateurs in 15 countries report communicating via this short-lived satellite.

OSCAR 4 was launched from Cape Kennedy on Dec. 21, 1965. A defect of the launch vehicle caused this satellite to be placed in a highly elliptical orbit, however, the first U.S. to Russia communications was provided by this satellite (Fig. 1-7). The craft employed a 2 meter to 70 cm transponder capable of three watts ouput. A failure of the craft's solar cells caused this satellite to die in March, 1966. A significant lesson in satellite range/altitude was acquired through this bird's misfortune. This information will be used in the Phase III era of long distance satellite communications, which is scheduled to begin in early 1980.

OSCAR 5 was built by students at Melbourne University in Australia, and launched from the U.S. Western Test Range on Jan. 23, 1979 (Fig. 1-8). AMSAT completed extensive modifications, testing, launch arrangements, licensing and data collection for this satellite project. This craft featured two elaborate telemetry systems for sending information concerning its health and well being back to earth. The information was used for planning future OSCAR satellites. One transmitter operated in the 2 meter band, and the other operated on 10 meters. Although this satellite lasted slightly over a month before its batteries discharged, over 200 reports for telemetry reception from amateurs in over 25 countries were received.

OSCAR 6, a highly outstanding amateur satellite, was launched from the U.S. Western Test Range on Oct. 15, 1972 (Fig. 1-9). This classic satellite featured a one watt 2 to 10 meter linear transponder which operated beautifully for over four years (Fig. 1-10). Magnetic stabilizing rods were used for accurately controlling satellite roll rate. OSCAR 6 was the first in a series of long-life satellites. Its internal Nicad battery package was continuously recharged by solar cells which covered the craft's outer perimeter. Thousands of reliable QSO's were accomplished by this perfectly operating satellite. Indeed, it seemed that OSCAR 6 could do no wrong. Each time the bird crossed your horizon, the 10 meter satellite band (29,450 to 29,550 kHz) sounded like contest time on 20 meters. The AGC system, which plays an extremely important role in the successful operation of all amateur radio satellites, was perfectly designed and adjusted. Additionally, all satellite users were quite conscientious and cooperative during this era of time. The overall results were that ground stations running low power and simple antenna systems could thoroughly enjoy satellite operations on a daily basis. During 1972, AMSAT received the ARRL Technical Merit Award for their outstanding leadership in the amateur space communications program which resulted in the success of OSCAR 6. Although this satellite is now defunct, its memories will last for many years.

OSCAR 7, the second long-life satellite open to amateurs around the world, was launched on Nov. 15, 1974, from the U.S. Western Test Range (Fig. 1-11). Two rather elaborate transponders and two telemetry/beacon transmitters are included in this spacecraft. The mode "A" transponder is a 2 meter input—10 meter output unit, and the mode "B" transponder is a 70 cm input—2 meter output unit. Both transponders run two watts output. OSCAR 7's electronic subsystems were developed by amateurs in the U.S., Australia, Canada and West Germany. AMSAT provided management and guidance for this project.

This spacecraft's capabilities and sophistication are comparable to the first six OSCAR satellites combined. The array of solar cells covering the satellite's outer perimeters are used for powering its electronics and charging its internal batteries. If the spacecraft is in sunlight, solar cells provide power. If the spacecraft is in darkness, the Nicad batteries provide power. Whenever the battery charge drops 60 per cent below full charge, the satellite switches to recharge mode (mode "C") for approximately 24 hours. At the end of this time, the satellite switches to mode B and continues normal operations. As this information is being written, OSCAR 7 is continuing to perform in an outstanding manner (Fig. 1-12). A slight problem with battery charging and baseplate temperature developed during early 1978, however, a minor change in the satellite's operating schedule appears to have corrected that situation. This problem and its corrective measure does indicate the satellite is showing its first signs of aging. As of mid-1978, OSCAR 7 is operating two days in mode B, and each third day in mode A. A check with recently published tracking data concerning OSCAR 7 will provide additional information on this outstanding amateur satellite.

The AGC system of OSCAR 7 is slightly more active than that of OSCAR 6, which means stations running excessively high power (over 200 watts in the case of OSCAR 7; OSCAR 8's AGC is fully activated at a much lower ERP level) reduce the satellite's sensitivity for other stations. No station should run more than 100 watts ERP. Presently, this situation is also being aggravated by stations

145.825

144.150 OSCAR NET

THE LATEST DEVELOPMENTS

OSCAR 8, our most elaborate satellite to date, was launched from Vandenburg Air Force Base in California on March 5, 1978. This bird was designed and built by amateurs in the U.S., Japan, Germany, and Canada (Fig. 1-13). The flawless launch of this craft produced a perfect orbit (Fig. 1-14), and OSCAR 8 is presently performing beautifully. The slightly lower altitude orbit of OSCAR 8, coupled with its package of new "space ready" electronics, has also resulted in a very sensitive and highly efficient satellite. Two very elaborate transponders and two telemetry/beacon transmitters are in operation aboard OSCAR 8. The mode A transponder is a 2 meter input, 10 meter output unit running approximately two watts. The Japanese-designed mode J transponder is a 2 meter input, 70 cm ouptut unit also running two watts.

Unlike OSCAR 7, the new OSCAR 8 is designed to operate in a positive power format (Fig. 1-15). Basically, this means its outer cover of solar cells and its Nicad battery pack are capable of producing and storing more power than the craft uses. This permits extended periods of operation in the popular mode A. Present calculations indicate that OSCAR 8 should operate for several years, and its orbit can be maintained beyond the year 2050. Barring unforeseen circumstances, this satellite will enjoy a long and prosperous life. OSCAR 8 is presently operating mode A during weekdays, and mode J during weekends. Up-to-the-minute satellite data can be obtained from the monthly amateur radio magazines.

The AGC system of OSCAR 8 is extremely active and highly responsive to all medium strength signals. Likewise, its highly sensitive receiver and low orbit are intended to allow amateurs running low power or simple "bush" communication setups to successfully communicate via OSCAR 8. On the other hand, amateurs running unnecessarily high ERP or a large group of amateurs simultaneously accessing OSCAR 8 will cause its AGC to heavily limit input levels. This results in low power ground stations experiencing difficulty accessing the satellite when power usurpers are present. As many old time satellite users realize, such situations relax after a satellite's newness wears thin. The prime consideration to realize is to stick by your ERP of no more than 100 watts and operate properly. Low power stations (25 to 40 watts ERP) will realize their best results when operating QRP nights. As an example of this, I recently enjoyed five QSO's during a single pass on QRP night while running a mere 12 watts ERP (Fig. 1-16).

AMSAT and its coordinated groups in several countries were responsible for OSCAR 8's construction activities and its placement in orbit. The American Radio Relay League has now assumed the administration and operational responsibilities for OSCAR 8, thus the ARRL is supplying information and technical data to interested parties.

Since OSCAR 8 is presently the star performer in our satellite program, a full description of its operation parameters and capabilities is included in Chapter 3.

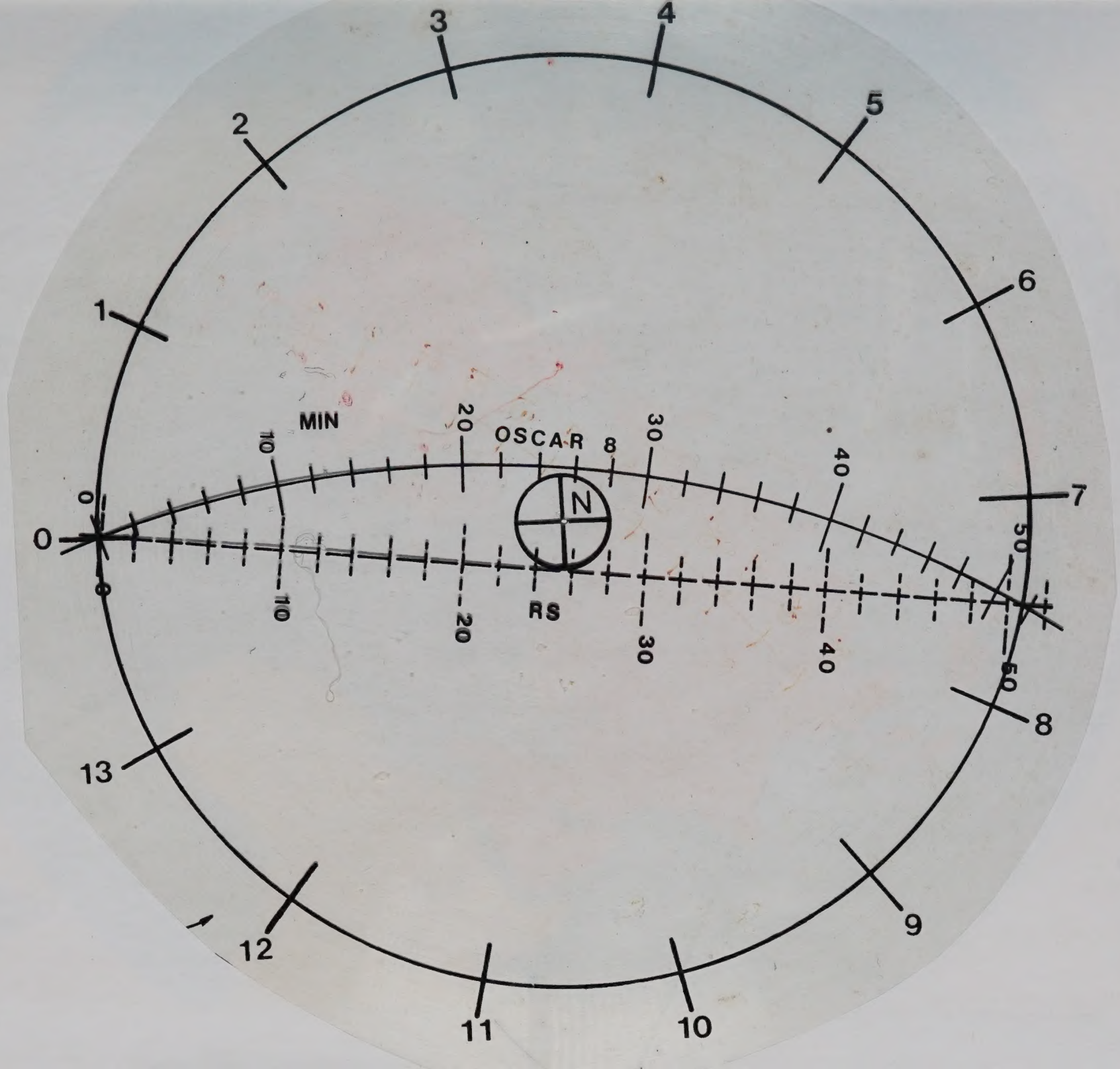
PHASE III

AMSAT is presently devoting its full efforts and resources toward completing the first Phase III satellite scheduled for launch in 1980. Considerable progress has been made. This fantastic satellite exceeds all previous OSCARs combined in technical sophistication and operation capability, and it provides amateurs with a truly new communications resource. In order to fully realize the impact of Phase III, a brief overview of the previous amateur satellites is in order. *Phase I* satellites (OSCAR 1 through 5) were short-life, low altitude "get acquainted" units. *Phase II* satellites (OSCAR 6, 7, and 8) are low altitude, long-life, full-communication satellites capable of relaying signals up to 5,000 miles for periods of 20 to 25 minutes at a time.

Phase III satellites, in comparison, are long-life, high-altitude elliptical orbit crafts capable of serving the complete northern hemisphere for 10 to 15 hours each day. In addition to providing efficient use of our VHF amateur bands for long distance communications, these satellites provide the following outstanding abilities:

- The equivalent of a new amateur band with the range capability of 20 meters, the reliability of 2 meters, and the traffic handling ability of 80 meters.
- A reliable means of transmitting specific information throughout entire continents.
- A transcontinental communication medium which may be reliably used for many hours daily by amateurs using relatively simple, low power setups.

The transponder included in the first Phase III satellite is a mode B unit operating 70 cm input and 2 meters output. The transponder runs approximately 50 watts to directional antennas which increase ERP to between 500 and 1,000 watts. A group of three adjacent frequency IF amplifiers, each with its own AGC system, prevent power usurpers or overcrowding conditions from loading the satellite's full output. Additionally, a strong signal seeking *notcher circuit* is incorporated in this arrangement to handle non-complying satellite users. An onboard microcomputer handles housekeeping functions of the craft. Additional information on Phase III is found in Chapter 3.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145.825
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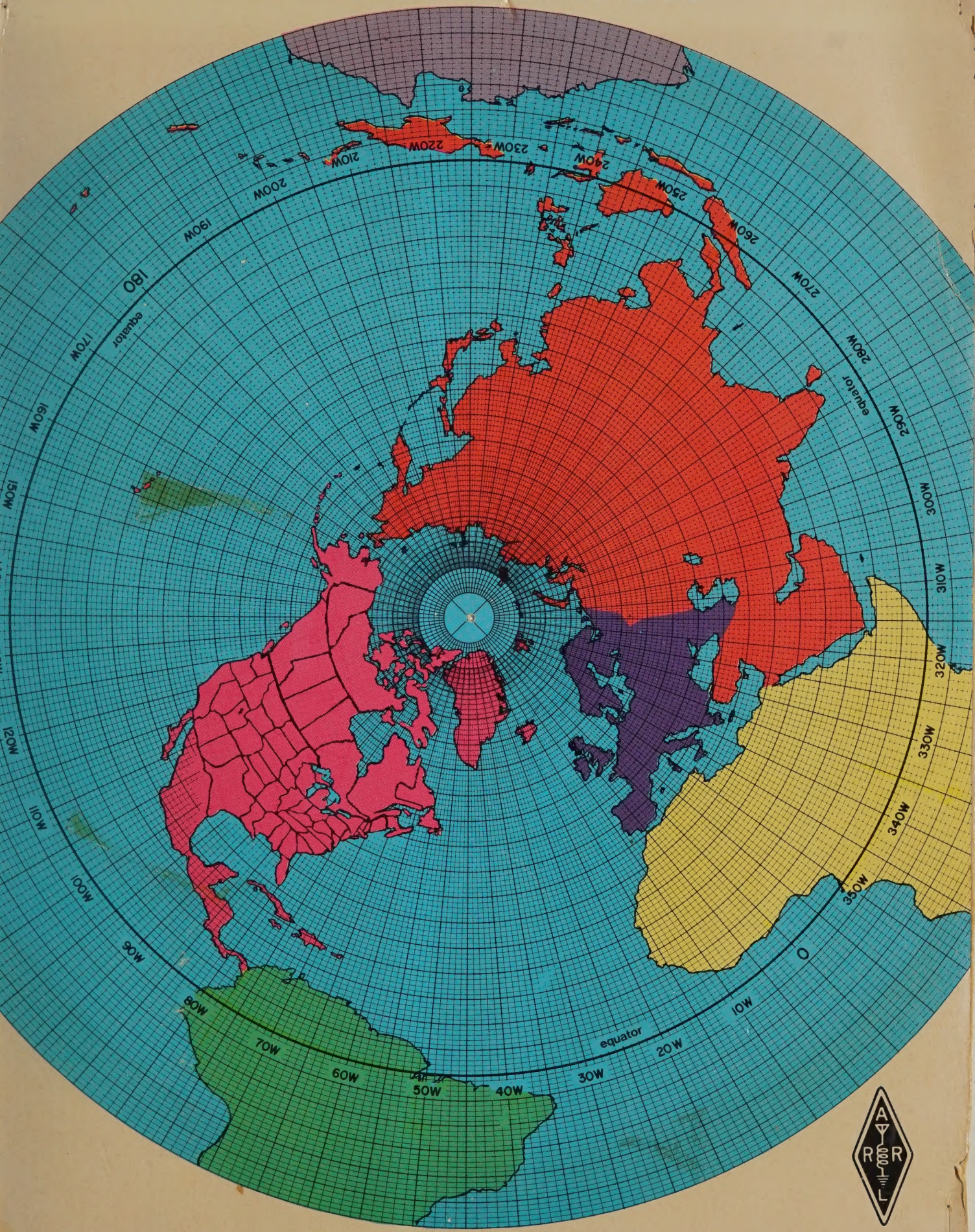
The transponder included in the first Phase III satellite is a mode B unit operating 70 cm input and 2 meters output. The transponder runs approximately 50 watts to directional antennas which increase ERP to between 500 and 1,000 watts. A group of three adjacent frequency IF amplifiers, each with its own AGC system, prevent power usurpers or overcrowding conditions from loading the satellite's full output. Additionally, a strong signal seeking *notcher circuit* is incorporated in this arrangement to handle non-complying satellite users. An onboard microcomputer handles housekeeping functions of the craft. Additional information on Phase III is found in Chapter 3.

OSCARLOCATOR



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OSCARLOCATOR

OSCAR/AMSAT
August 27 1981
Lecture notes
C. Buttschardt
W6HDO

In the very near future, in fact in a matter of weeks, another amateur radio satellite is to be launched. Again, an international flavor is to be preserved as was OSCAR 5 "Austraillius" and JAMSAT-OSCAR, built by Japanese amateurs. The next satellite to be launched was built by amateurs in the United Kingdom and named UoSAT. UoSAT was built by students and faculty of the University of Surrey. The satellite transmits only and no relaying of signals will occur, however, there will be massive amounts of data to be analyzed. Some examples are:

telemetry
60 channels of analog data and 45 digital data points within the satellite
1200, 600, 300, 110 and 75 baud ASCII
45.5 baud Baudot
20 word per minute morse code
Synthesized voice announcements

data beacons
145.825 MHz
435.025 MHz
2304.1 MHz
10250 MHz

propagation studies and educational experiments
Phase referenced beacons on 7.050, 14.002, 21.002, 28.002 MHz
An earth pointing, solid state charge coupled device camera which will provide land and sea detail data via digital transmission. Resolution should be excellent as 16 shades of grey will be provided.

Within the next few years three phase three satellites are to be constructed. The frequency use plan has already been decided upon, within practical limits, and these are presented for future planning purposes:

All phase three satellites are in highly ellipitical orbits. All have two meter down links in the 145.825 to 145.975 in the B mode. The uplink has not been decided upon due to recent measurements made in Germany, the constructors of phase IIIA. It appears that the 435 MHz band will be used at this time.

Downlinks are:	Phase IIIB	436.150 to 436.950
	Phase IIIC	437.150 to 437.950
Uplinks are:	Phase IIIB	435.025 to 435.175
	Phase IIIC	435.425 to 435.575
	Phase IIIB	1269.05 to 1269.95
	Phase IIIC	1268.05 to 1268.95

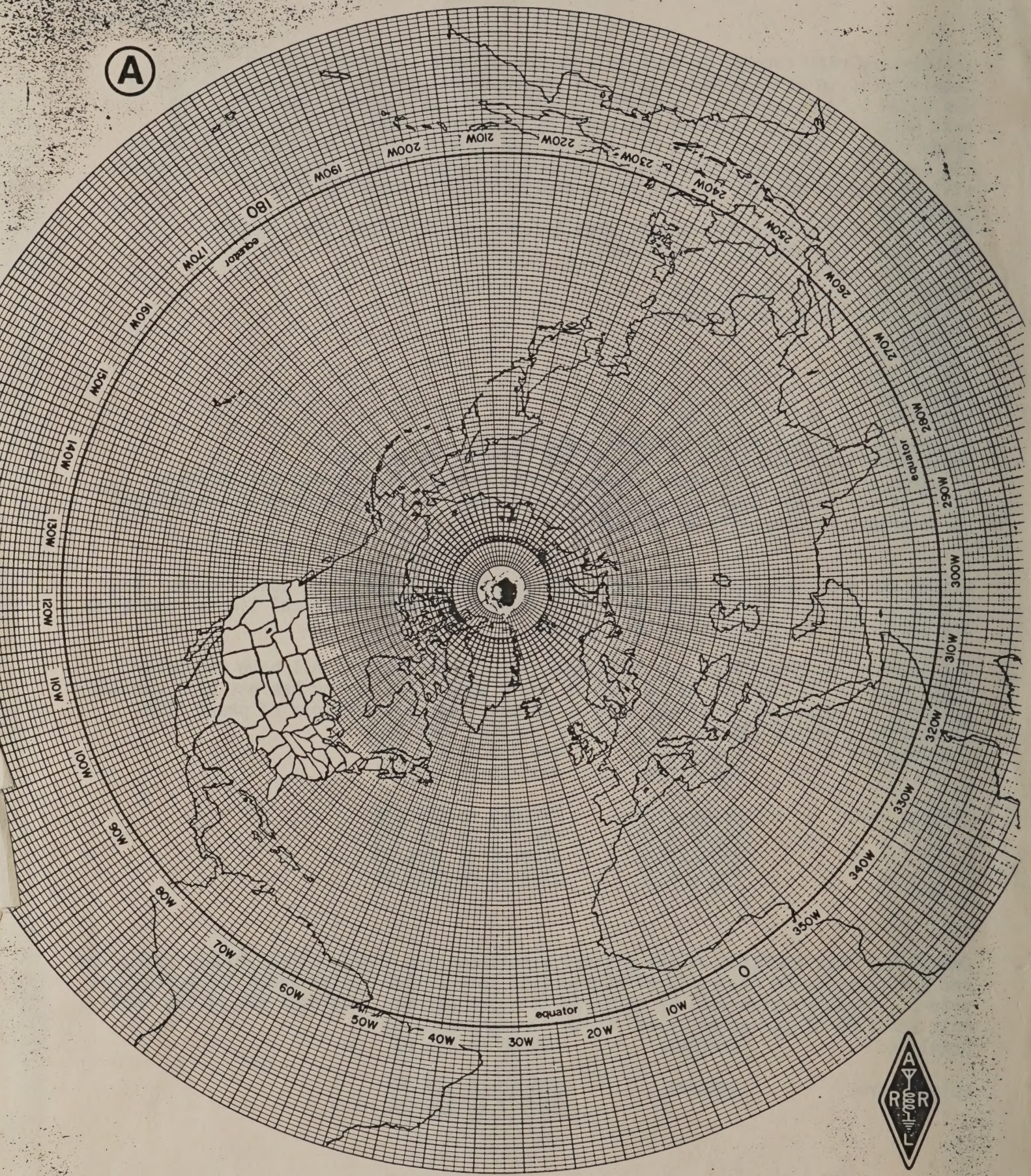
One of the most exciting of the planned satellites are those called SYNCART satellites and are those to be placed in 24 hour orbits some 18,000 miles above the earths equator!! Communication will be possible 24 hours per day from over 80% of the land mass and 100% of the ocean area. These frequencies are:

Downlink:	SYNCART	435.60 to 435.90
Uplinks are:	SYNCART	145.60 to 145.80
		1267.7 to 1268.0

AND THIS IS ONLY THE START OF BETTER AMATEUR RADIO!!!

W6HDO

OSCARLOCATOR



Special Thanks to K2ZRO

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